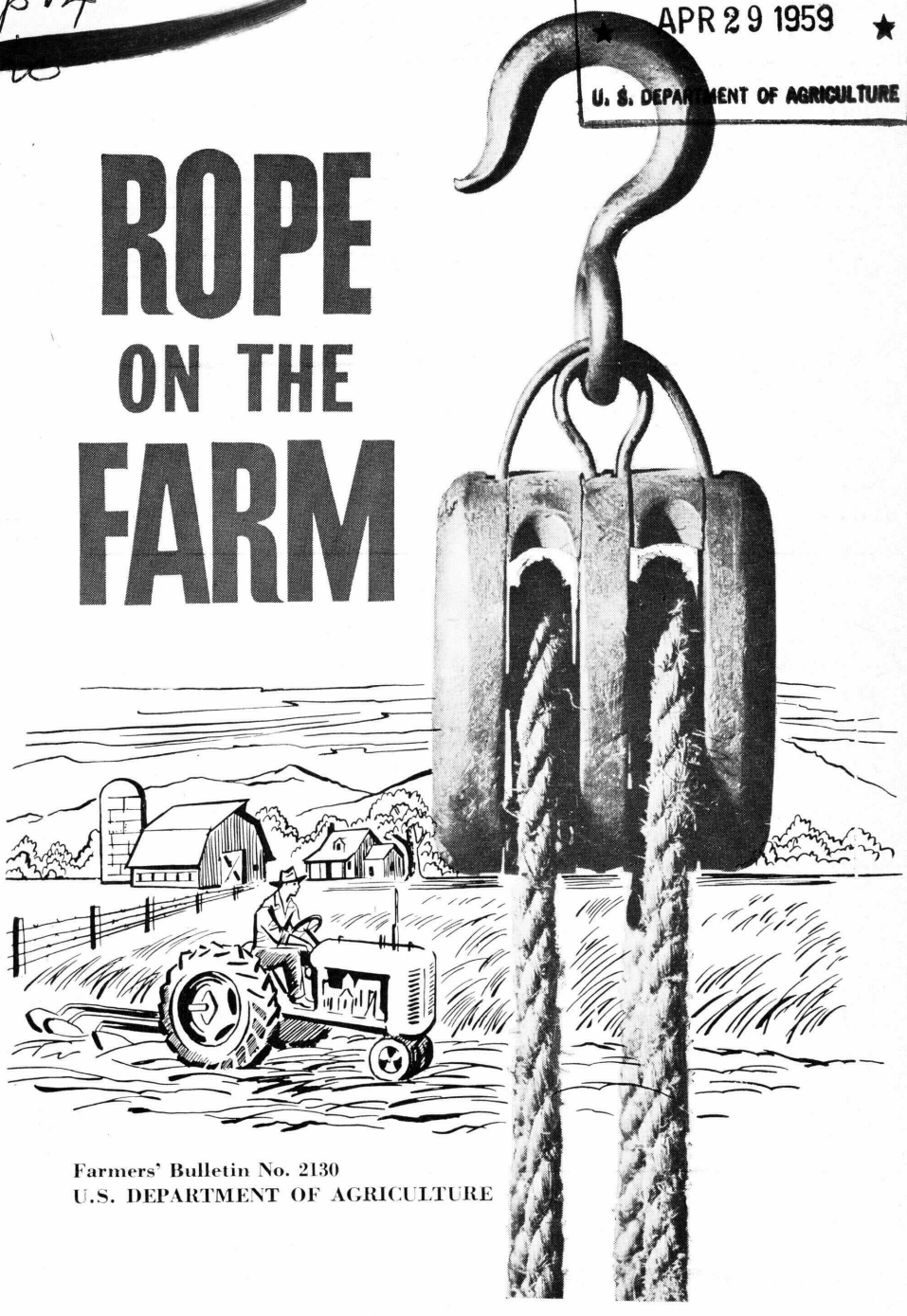
ROPE ON THE FARM



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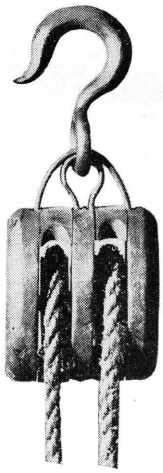

By J. R. McCalmont, agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service

Most natural fiber rope manufactured in the United States is made from manila fiber imported from the Philippines, and from sisal fiber imported from the East Indies and Africa.

The development of synthetic fibers—nylon, dacron, orlon, saran, glass fiber, and polyethylene—has made possible the production of rope with special characteristics for unusual requirements.

Wire rope is becoming more common on farms wherever great strength is more important than flexibility. Many modern farm machines require wire rope in their operations.

SELECTION

In selecting rope, consider its strength, durability, and flexibility. These characteristics depend on the size of the rope and the material of which it is made. They may vary in importance according to the job at hand.

Natural Fiber Rope

Manila fiber makes the best and strongest natural fiber rope. Sisal fiber rope, 75 to 80 percent as strong as manila, is less flexible but more resistant to abrasion than manila rope. Cotton fiber rope—used for packaging, clotheslines, sash cords—is not satisfactory for general farm use.

Synthetic Fiber Rope

Synthetic fiber rope made from nylon or dacron is stronger than manila rope. It is especially useful under wet conditions because the fibers do not absorb water and are not damaged by rot or mildew. Such rope is best adapted for use as towlines, starter ropes, and lariats.

Nylon rope is resistant to damage by petroleum oils, solvents, and alkalies, but can be damaged by acids, paints, and linseed oil. Dacron rope is highly resistant to acids, heat, and insect damage.

Other synthetic fibers used in ropemaking are saran, glass, and polyethylene. Saran rope is resistant to damage by acids and alkalies. Glass fiber rope is resistant to high temperature. Polyethylene rope, being lighter than water, will float.

Wire Rope

Wire rope is made from steel wires wound on a fiber core or on a smaller wire-rope core. The type of core, as well as the size of the individual steel wires, determines the strength and flexibility of the rope. The rope's resistance to abrasion and to crushing are also determined by its construction.

Some wire rope is preformed

when it is manufactured. Preforming prevents unraveling or unwinding when the rope is cut. Preformed wire rope is also more flexible and easier to handle without kinking it.

Use fiber-core wire rope for jobs requiring extra flexibility. However, since a steel wire core increases the strength of wire rope 7½ percent, use wire-core rope for jobs requiring extra strength.

Several kinds of steel wire are used to make wire rope. Of these, the least expensive and most available is wire made from plow steel or improved plow steel.

Wire rope made from large individual wires resists abrasion better than rope made from small wires, but is less flexible.

Resistance to crushing is not usually as important in farm jobs as flexibility and abrasion resistance, but it becomes important when wire rope is wound under heavy loads on small drums.

Wire rope that has an independent wire-rope core is more resistant to crushing but is less flexible than fiber-core wire rope.

FIBER ROPE

All fiber rope—either natural or synthetic—lasts longer and gives better service if it is used with care from the day it is bought. Crushing, abrasion, and exposure to dirt and dampness are the chief causes of rope weakness and breakage.

New rope is stronger than used rope because it is clean, dry, tightly twisted, and unworn. Frayed, unraveled, and kinked rope does not last long and cannot be depended on for strength.

Do not try to make a small rope do the work of a large one. Safe working strengths of typical sizes of fiber ropes are given in table 1.

Fiber rope is often sold by weight. Refer to table 2 for approximate length per pound of typical kinds of rope.

Preparing New Rope for Use

It is important to prepare new fiber rope before it is used. Uncoil it from the center of the coil in a counterclockwise direction. This prevents twists and kinks from forming. Turn the whole coil over if the rope begins to uncoil in a clockwise direction.

To straighten a short-length of new rope, hang it from one end and attach a light weight at the bottom.

Long ropes can be straightened by dragging them across a smooth pasture or meadow. Do not drag them on a dirt road, on cultivated land, or across sand. Such treatment injures the fibers.

TABLE 1.—*Safe working strength of new fiber rope, by size of rope and kind of fiber*

[Actual breaking strengths are at least 5 times the figures given]

Rope diameter	Working strength					
	Natural fiber		Synthetic fiber			
	Manila	Sisal	Nylon	Dacron	Polyethylene	Saran
Inches	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
⅜	200	150	400	390	300	150
½	440	350	780	745	600	300
⅝	880	700	1, 710	1, 355	1, 100	620
¾	1, 080	865	2, 000	1, 870	1, 600	800
⅞	1, 540	1, 230	2, 700	2, 520	2, 120	1, 140
1	1, 800	1, 440	3, 600	3, 220	2, 800	1, 600

TABLE 2.—*Approximate number of feet per pound of new rope, by size of rope and kind of fiber*

Rope diameter	Approximate number of feet per pound					
	Natural fiber		Synthetic fiber			
	Manila	Sisal	Nylon	Dacron	Polyethylene	Saran
Inches	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
3/8	24. 5	24. 5	26. 3	26. 3	35. 0	18. 0
1/2	13. 6	13. 6	15. 0	15. 0	20. 0	10. 0
5/8	7. 5	7. 5	10. 0	10. 0	12. 5	5. 7
3/4	6. 0	6. 0	6. 6	6. 6	8. 5	4. 3
7/8	4. 5	4. 5	5. 0	5. 0	6. 6	3. 1
1	3. 7	3. 7	3. 6	3. 6	5. 0	2. 4

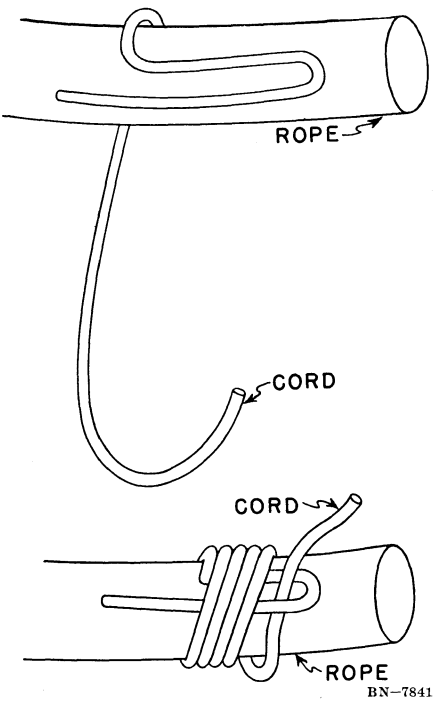

FIGURE 1.—**Whipping a rope.** Lay a narrow loop of cord about 2 inches along the rope with the open end away from the end of the rope. Hold the open end of the loop against the rope until the winding begins. Starting near this open end, wind the long end of the cord closely toward the end of the rope. Wind the cord tightly and in the direction of the twist of the rope until the windings about equal the diameter of the rope. Thread the end of the cord through the loop, pull the loop halfway under the windings with the other end of the cord, and trim off the two ends of the cord even with the windings.

Whip the ends of fiber ropes with strong cord to protect them against unraveling. (See fig. 1.)

Splicing

Fiber ropes are tied to each other or to other objects by using splices, knots, or hitches.

Use splices instead of knots whenever possible. A spliced rope is 80 to 90 percent as strong as a solid rope, but a knotted rope has only 50 to 60 percent of the full strength.

Use splices to fasten rope permanently. Ropes to be spliced must be of the same size, tightly twisted, and in good condition. Use a smooth finished, tapered pin of waxed hardwood about a foot long to separate strands when splicing heavy rope.

Whip the ends of each strand of a rope over 1 inch in diameter.

Keep twisting each strand tight as the splice is being made. Keep the splice even at all times. If two strands go under one strand, remove them and reweave them correctly.

Finish all splices by trimming strand ends and rolling the splice on a smooth surface.

Use a short splice if the increased diameter of the splice does not matter. (See fig. 2.)

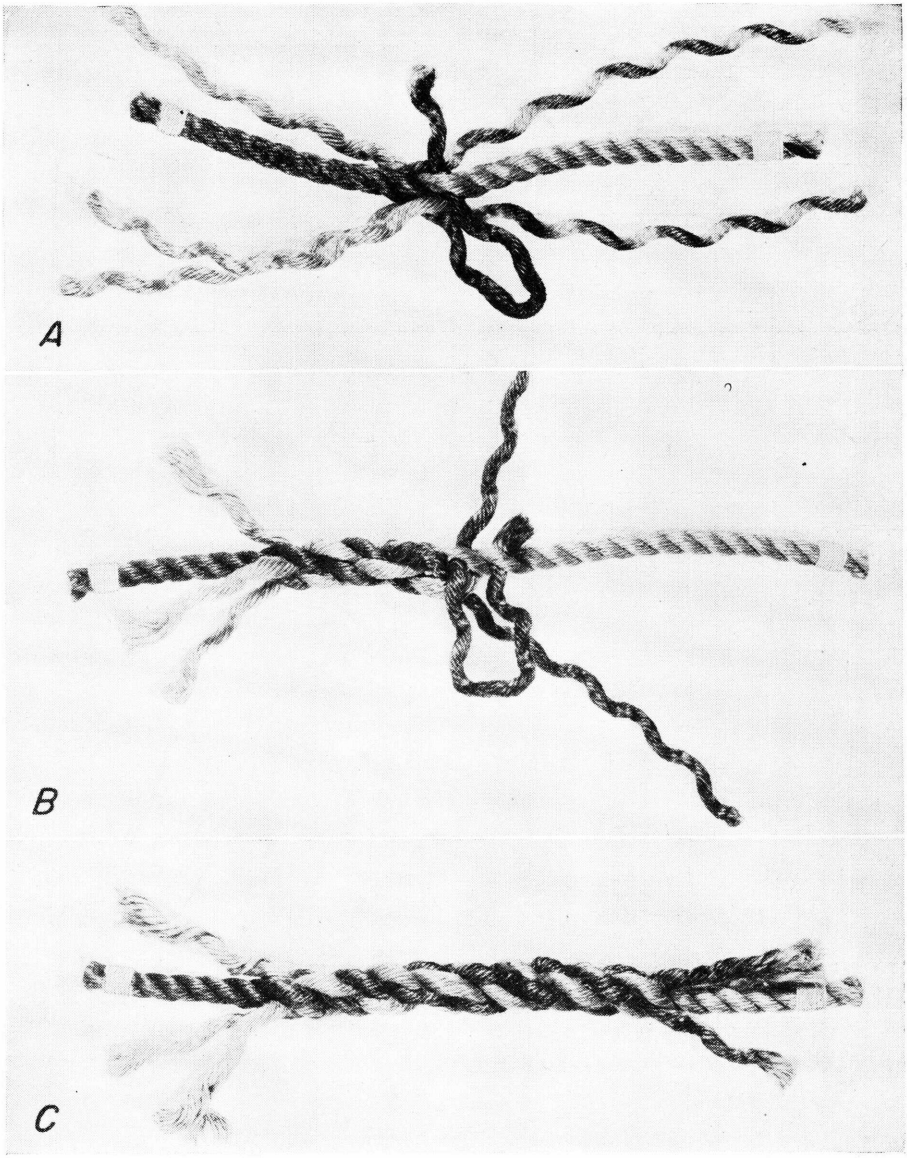

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FIGURE 2.—**The short splice.** Untwist each rope end several turns. Join the two rope ends so that each strand of one rope lies between two strands of the other. Moving across the twist of the rope, take any one strand end over the neighboring strand and thread it under the next strand (A). Take another strand end and repeat the over and under weave. Take the remaining strand end and repeat the weave again. Twist all three and lightly pull them tight (B). They should come out at even spaces around the rope. Now weave the strand ends of the second rope into the strands of the first in exactly the same way. Repeat the weaving on both ropes at least two times for each strand end (C).

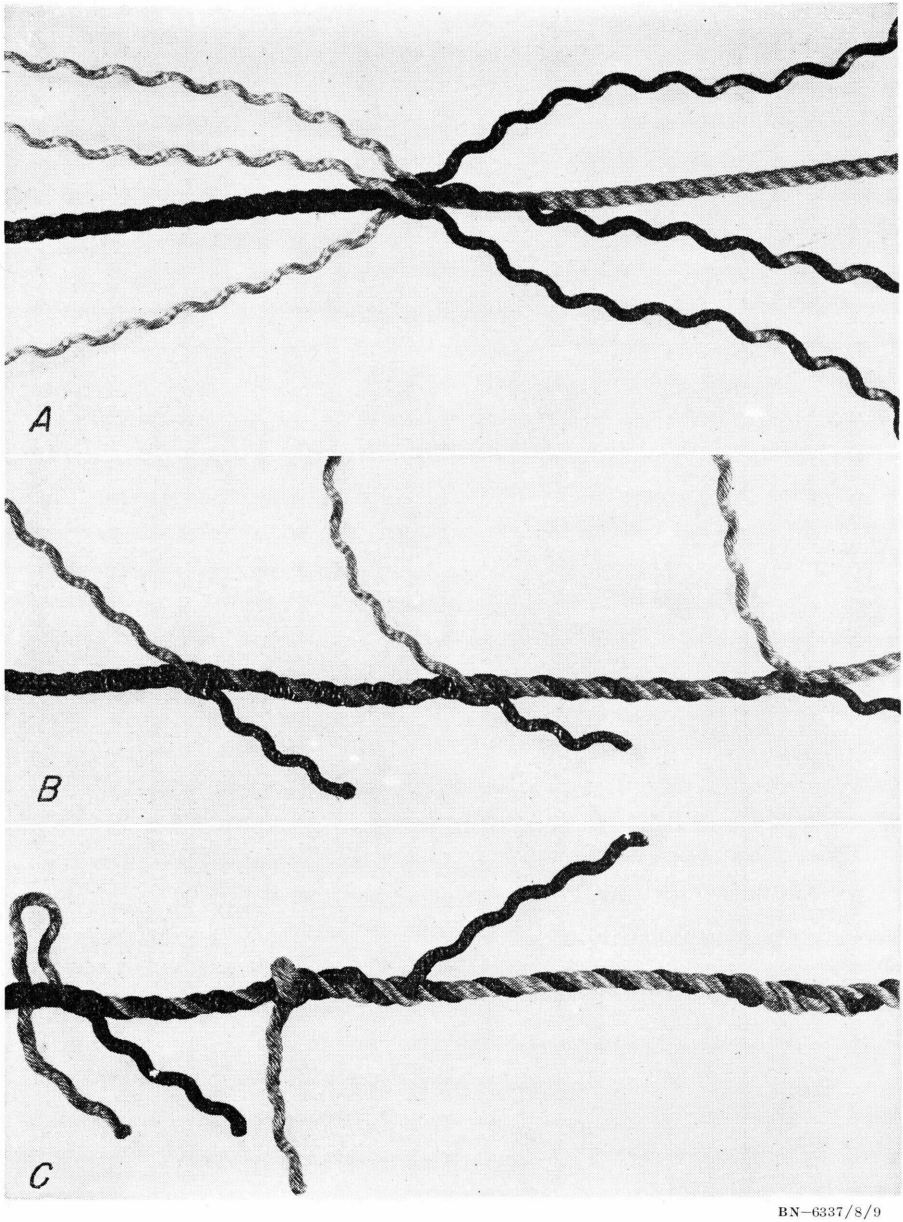

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FIGURE 3.—**The long splice.** Untwist the two rope ends about 15 turns each. Join the ends so that each strand of one rope lies between two strands of the other (A). Untwist a strand end of one rope about 5 turns away from the joining point. Lay the corresponding strand end of the other rope, firmly twisted, into the open groove. Untwist a strand end from the other rope and replace it with the corresponding strand in the same way. There will now be a pair of corresponding strand ends in the middle, and a pair of strand ends at either side of the original joining (B). Trim all the strand ends to the same length. Weave each strand end in turn, across the direction of the rope twist, over the first strand and under the second. Repeat this weaving at least twice for each strand end (C).

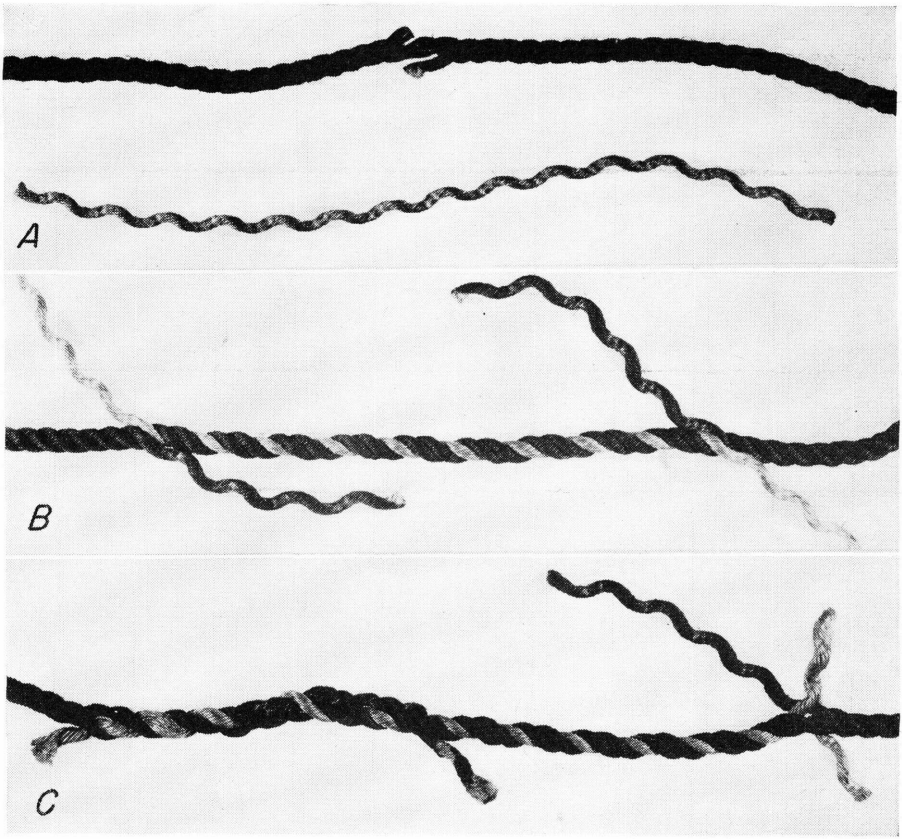

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FIGURE 4.—**Repairing a broken strand.** Untwist the ends of the broken strand 6 or 8 turns on either side of the break (A). Replace the broken strand with a strand of sound rope about a foot longer than necessary to fill the space left by the removal of the broken strand (B). Weave the ends of the strands into the rope as done in the long splice (C).

Use a long splice to join ropes that are to be used on pulleys or in blocks. (See fig. 3.)

A broken strand in a fiber rope can be mended in an emergency by substituting a length of unbroken strand from another rope of the same diameter. (See fig. 4.)

Use an eye splice to form a permanent loop on the end of a rope. (See fig. 5.)

Use a crown splice to finish the end of a rope permanently if the extra diameter of the splice does not matter. (See fig. 6.)

Knot Tying

Use hitches and knots for temporary fastenings, or for fastenings that need adjustment from time to time.

Use the square knot to tie two ropes or cords together. (See fig. 7.) If the knot will be under a heavy strain, put a tapered metal or wood rod through the center before the knot is pulled tight. Removing the rod makes untying the knot easy.

The sheet bend, or weaver's knot (fig. 8), is especially useful for joining two ropes of different diameters,

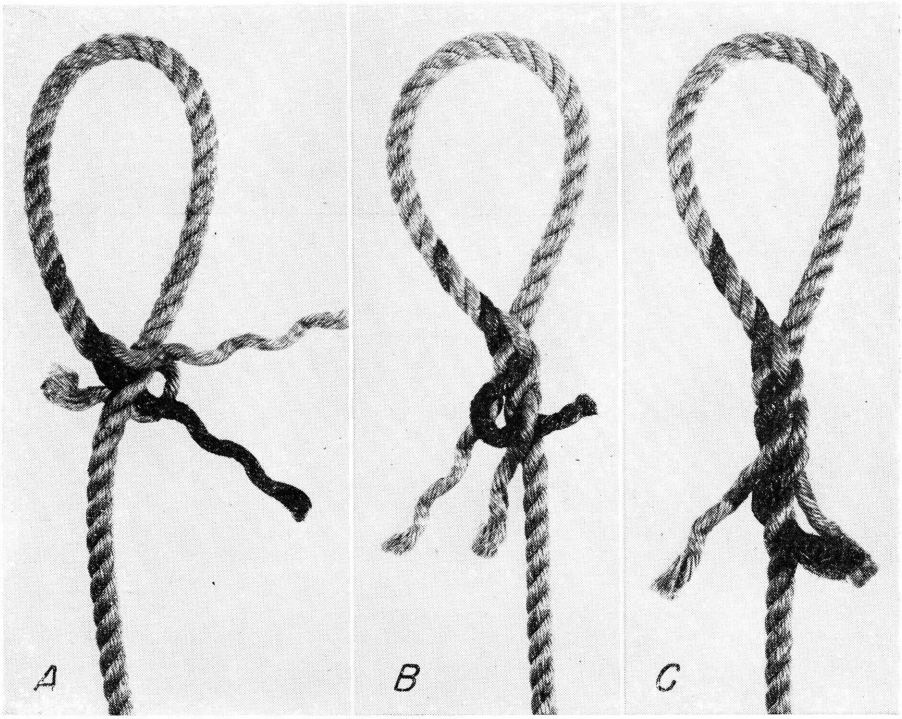

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FIGURE 5.—**The eye splice.** Untwist the rope end 5 or 6 turns. If the loop is to go through a ring, put it through at this time. Press the untwisted end against the rope and tuck the center strand end under the nearest strand of the rope (A). Pull the strand end tight. Take another strand end, twist it firmly, and carry it over the same strand that the first went under and then under the next strand (B). Tuck the last strand end over the strand that the second went under, and under the remaining strand. The strand ends should now stick out at equal distances around the rope and the joining with the rope should be close and even. Weave each strand end at least twice more over and under the strands of the rope (C).

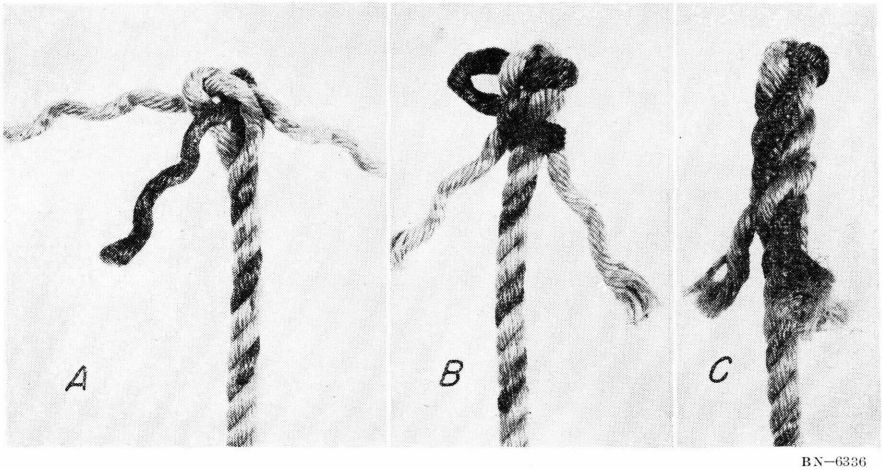

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FIGURE 6.—**The crown splice.** Untwist 5 or 6 turns of the rope end. Fold one strand end back on the rope to form a loop. Take up the next strand end away from the direction of the twist of the rope and carry it across this first strand end. Carry the next strand end across this second strand end, and then thread it through the loop formed by the first strand end. Pull the strand ends firmly. They should stand out in three equal directions at almost right angles to the rope (A). Take one of the strand ends back across the next strand and under the strand next in order (B). Repeat this with the two other strand ends. Pull the strand ends tight and weave them at least twice more in the same manner (C).

or for any job where quick untying is desired.

Use the bowline (fig. 9) to make a temporary nonslipping eye loop on the end of a rope.

Use the pipe hitch to hoist pipe or smooth poles vertically. (See fig. 10.)

Using the anchor, or fisherman's, bend to fasten a rope to a ring makes the rope last longer than using a simple loop, because the wearing surface of the rope is doubled. (See fig. 11.)

The half hitch (fig. 12) is a temporary fastening for ropes under strain. It is also used with other knots or hitches as an extra fastening to reinforce the basic knot.

Use the timber hitch for dragging or hoisting poles or timbers. It has more turns than the half hitch and holds better. (See fig. 13.)

The Blackwall hitch (fig. 14), is a half hitch used to attach a rope to a hook temporarily.

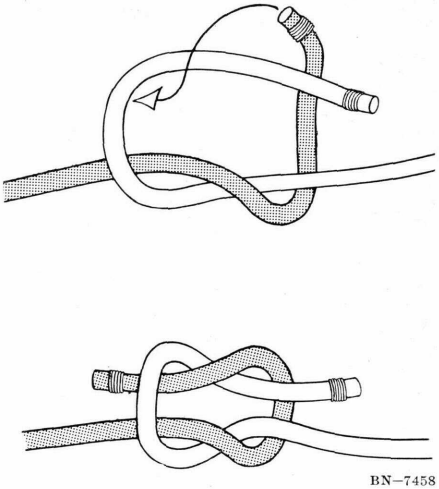

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FIGURE 7.—**The square knot.** Place the two rope ends together with the right-hand rope crossing the left-hand rope, and passing under it. Then place the rope end now in the left hand across the rope in the right and insert it in the loop that has been formed in the other rope. Pull on the two ropes to complete the knot.

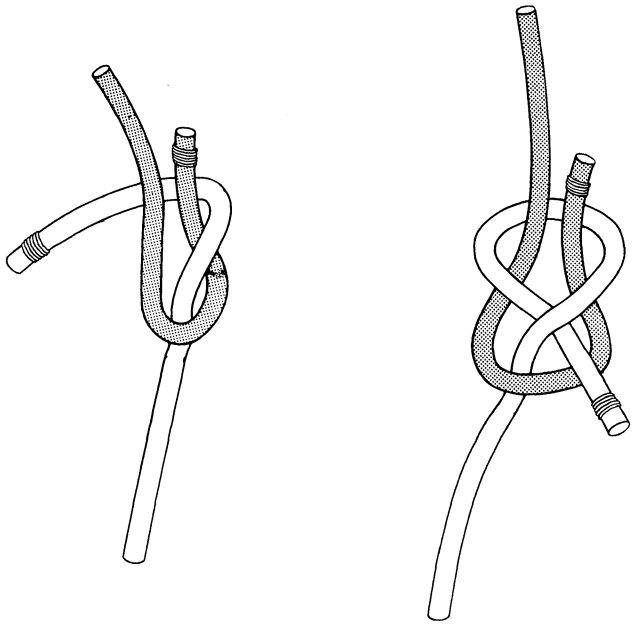

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FIGURE 8.—**The sheet bend.** Form a loop in the end of the larger rope. Pass the smaller rope through the loop, around the opposite side, and back between itself and the large rope. Pull the smaller rope to set the knot.

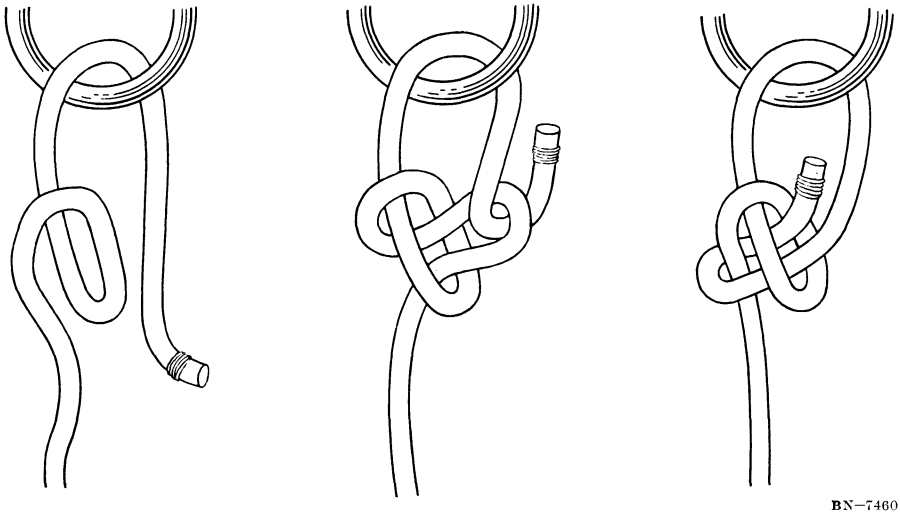

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FIGURE 9.—**The bowline.** Thread the rope end through any ring, or around any fixed object that is to be used. Bring the rope end alongside the rope. Make a small circular loop in the rope, facing the rope end, near the point where they meet. Push another small loop from the main rope through the first loop. Then insert the rope end through the second small loop, turn it back on itself and hold it fast while pulling the main rope until the knot is set.

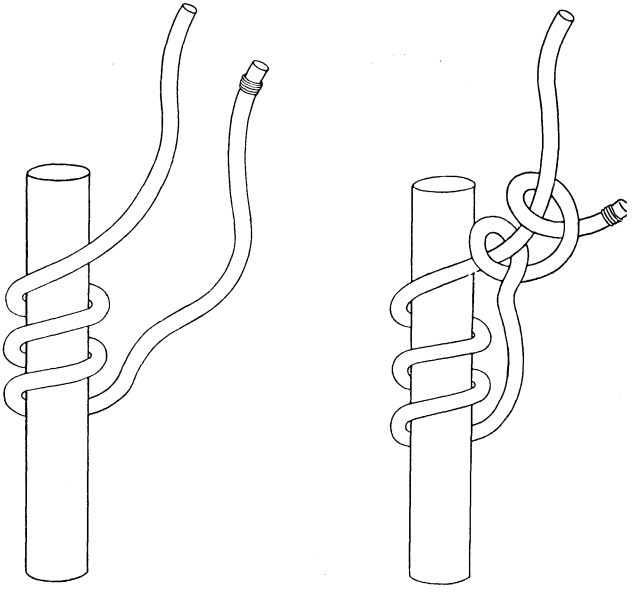

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FIGURE 10.—**The pipe hitch.** Take 3 or 4 turns around the pipe with the rope end. Secure the rope end by two half hitches around the rope. Another pipe hitch is made by using a half hitch on the half of the pipe to be carried high, and making a timber hitch with the rope end farther toward the center of the pipe.

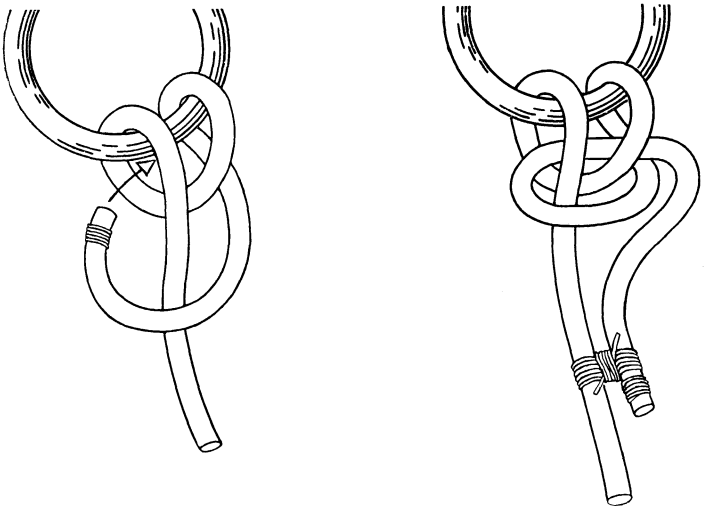

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FIGURE 11.—**The anchor bend.** Pass two loose turns of the rope end through the ring, then across the rope, and finally insert the rope end alongside the ring through the first turn and then the second turn. A half hitch is then usually tied to secure the end of the rope. Whether it is used or not, the rope end is finally seized to the rope with strong cord to prevent its pulling loose under strain.

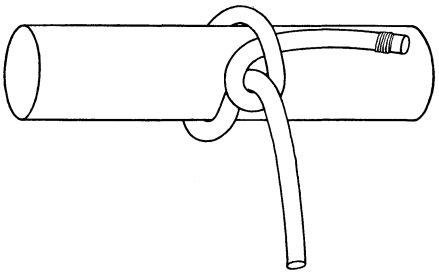

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FIGURE 12.—**The half hitch.** Pass the end of the rope around the ring or other object to which the rope is to be fastened, carry the rope end around the rope and pull it back under itself. Pull the rope tight to set the hitch.

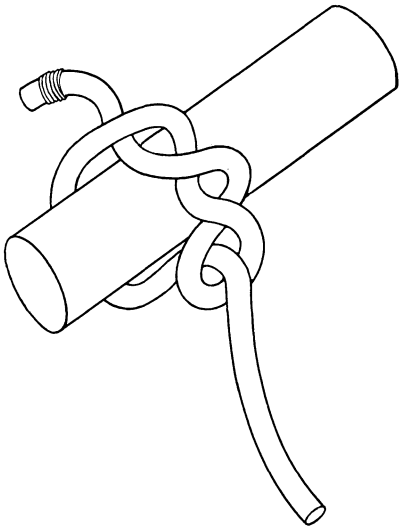

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FIGURE 13.—**The timber hitch.** Pass the end of the rope around the object to be dragged, carry the rope end around the rope, then pass it back around itself several times.

Blocks and Tackle

Blocks are pulleys mounted in frames. Blocks with 1 pulley are called single blocks; those with 2 pulleys are called double blocks. Frames of blocks have hooks or rings attached to them for hanging the blocks in whatever position necessary. Some blocks have a "becket," or a small ring, fixed to the frame opposite the hook.

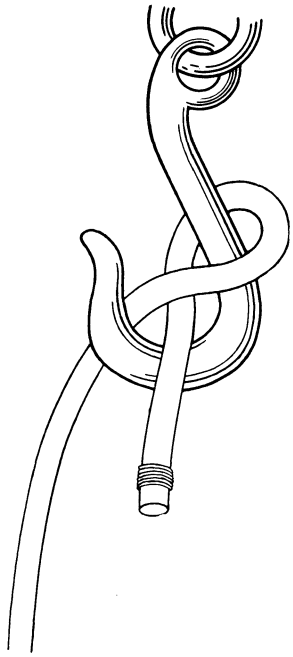

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FIGURE 14. **The Blackwall hitch.** Pass the rope end behind the body of the hook and cross it under the rope in the mouth of the hook. Pull tight and apply the load on the hitch gradually so that the rope jams firmly on the hook.

One block may be used simply to change the direction of a rope. Two blocks, properly threaded ("reeved") with rope can produce more pulling power than one block, and do so with less effort. Such a set of blocks is called a block and tackle, block and falls, or a set of falls. A single-and-double block and tackle has one single and one double block; whereas a double-and-double block and tackle has two double blocks. (See fig. 15.)

When a tackle is ready for use, the block at the top is called the fall, or fix, block, and the lower block is called the movable block. Always use the block with the fewer pulleys as the movable block. The rope that is pulled when the tackle is being used is called the fall rope.

To give the best service, equipment used with rope must be kept in good condition. Use the proper size pulleys for each rope. The life of a rope is shortened when it is used with too small diameter pulleys, because the rope fibers are crushed by the sharp bending under strain. For ropes up to 1 inch in diameter, select a block with a frame, or shell, whose length measures 8 times the diameter of the rope. For 1-inch rope, use a block with a 9-inch frame.

Use powdered graphite to lubricate ropes that will run over pulleys for any length of time. Smooth the graphite powder on the rope with the hand.

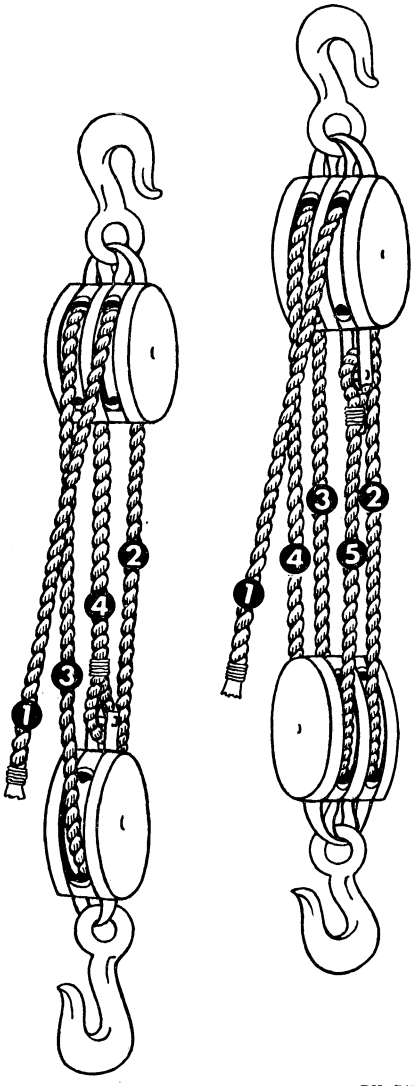

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FIGURE 15.—**Block and tackle.** *A*, Single-and-double block and tackle; *B*, double-and-double block and tackle. In these examples, the mechanical advantage is equal to one less than the number of ropes between the blocks.

Maintenance

Care in storing and handling lengthens the useful life of rope.

Inspect rope often for general condition and weak spots.

Keep natural fiber rope out of direct sunlight, and damp or hot places. Use tarred natural fiber rope or synthetic fiber rope where dampness is common. In rainy weather loosen rope between fixed objects outdoors.

When rope is wet, hang it in the shade to dry. Do not let wet rope freeze.

Protect natural fiber rope from acids, drying oils, chemicals, and strong fumes. Use synthetic fiber rope for work where these are present.

Do not pull rope to straighten out kinks; unwind it properly.

Do not drag rope over rough surfaces, through sand or cinders, or around sharp corners.

Store rope in an airy, sheltered place. Coil rope on a raised platform of wooden slats, or hang it in loose coils from wooden pegs.

Do not store rope close to the heat of boilers or furnaces.

Do not store rope when it is wet. This causes dry rot.

WIRE ROPE

Wire rope is the strongest rope available. It is made in a large variety of sizes and strengths. The sizes are identified by the usual diameter measurements and, in addi-

tion, by paired numbers—for example, 6 x 7. The first number indicates the number of strands in the rope and the second the number of wires in each strand. A 6 x 7 fiber-core wire rope has 6 strands of 7 wires each, and the strands are wound on a fiber core. (See fig. 16.)

The diameter and strength of wire rope are governed by the type of core used and by the strength of the steel in the individual wires.

Although wire rope is very strong compared to fiber rope, it is still important to use the proper size wire rope for every job. Table 3 gives safe working strengths for typical sizes of plow steel and improved plow steel rope.

Preparing New Rope for Use

Unreel wire rope by mounting the reel on an axle between jacks, or by placing it on a turntable, or by rolling it along the ground in a straight line.

Seize all ends of wire rope with windings of annealed iron seizing wire to prevent unraveling.

Before cutting wire rope, make 2 or 3 evenly spaced windings of 7 or 8 turns each with this seizing wire on each side of the place to be cut. Leave about ½ inch between the cut and the first winding on each side for wire rope less than ½ inch in diameter. For wire rope up to an inch in diameter, leave about 1 inch of space on each side of the place to be cut.

Fastenings

Wire rope is fastened by using clips, sockets, and splices. Sockets and splices require special tools and considerable practice. Get directions for these operations from the wire rope manufacturers.

The quickest and easiest way to fasten wire rope is to use clips. Both **U**- and **L**-shaped clips are available. **L**-shaped clips, which do not deform either wire, are desirable for joining two wire ropes.

Use clips and wire rope thimbles for forming eye-loops at rope ends. (See fig. 17.) Loop the rope end over the thimble and carry it back along the rope. Use seizing wire to hold the parts. Fasten a clip near the rope end, put a strain on the eye and then fasten another clip snug up to the narrow part of the thimble.

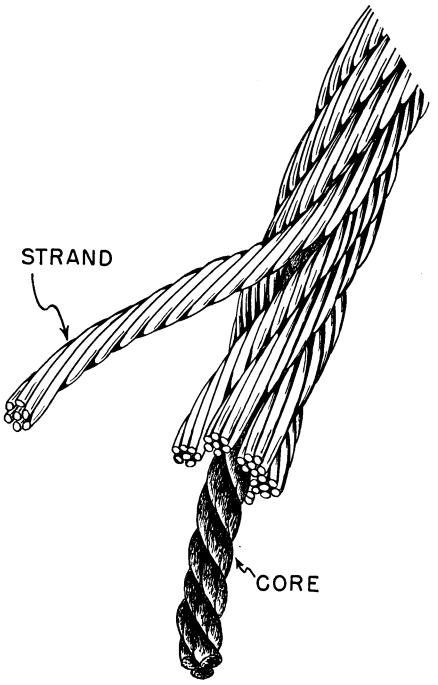

FIGURE 16.—Construction of a wire rope.

When using **U**-bolt clips, always put the casting on the main part of the rope and draw the rope end to it with the **U**-bolt. This limits the deforming of the rope by the bolt pressure to the rope ends.

Use two clips and two seizings for fastening all wire ropes up to 7/16 inch diameter. Use three clips and three seizings for all wire ropes from 7/16 inch to ¾ inch diameter. Ropes over ¾ inch require four clips and three seizings.

TABLE 3.—*Safe working strength of new fiber-core wire rope, by size of rope and kind of steel*

[Actual breaking strengths are at least 5 times the figures given]

Rope diameter	Working strength			
	Plow steel		Improved plow steel	
	6 x 37 construction	6 x 19 construction	6 x 37 construction	6 x 19 construction
Inches	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1/4	900	956	1,036	1,096
5/16	1,400	1,484	1,612	1,704
3/8	2,008	2,124	2,308	2,420
7/16	2,720	2,876	3,128	3,308
1/2	3,540	3,740	4,080	4,280
5/8	5,480	5,800	6,320	6,680
3/4	7,840	8,280	9,040	9,520

Maintenance

Inspect wire-rope clips often. Wire rope stretches under strain and the clips may become loose. Retighten all clips after the rope has been used.

Wire rope used in farm machinery is designed for satisfactory service and economy. Usually wire rope for repairing such machines is easiest to get as factory replacement parts. If this is not possible, get the same size and type wire rope for a replacement. Always follow the manufacturer's instructions.

If the same size and type is not available, get a stronger rope with nearly the same overall characteristics. Be certain the replacement wire rope fits sheave and drum grooves on the machine. Recommended tread diameters of sheaves and drums for typical wire rope sizes are given in table 4.

Store wire rope in a clean dry place at a distance from corrosive materials like fertilizers, sprays, silage acids, and manure.

Clean wire rope with a wire brush, compressed air, or live steam.

Wire rope must be lubricated. Use a lubricant recommended by the manufacturer, or any good lubricant free from acids and alkalies. Choose a lubricant that penetrates the wire and clings to the wire surfaces.

Clean wire rope on stored farm machines, and cover it with grease. Be careful not to rest machines or equipment on the wire rope.

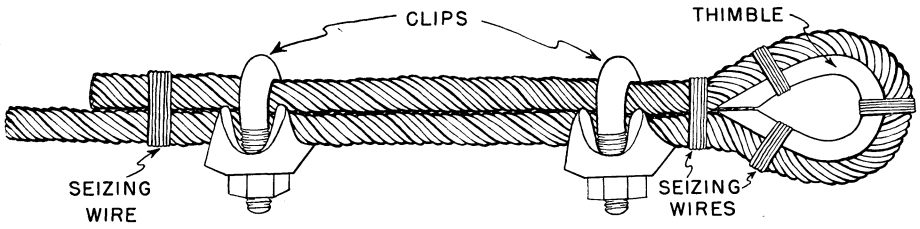

FIGURE 17.—Use of clips, seizing wire, and a thimble to make an eye loop on wire rope.

TABLE 4.—*Tread diameter of sheaves and drums for typical wire-rope sizes*

Rope diameter	Tread diameter of sheaves and drums [1]			
	Minimum		Average	
	6 x 19 construction	6 x 37 construction	6 x 19 construction	6 x 37 construction
Inches	*Inches*	*Inches*	*Inches*	*Inches*
1/4	7 1/2	4 1/2	11 1/4	6 3/4
5/16	9 1/2	5 5/8	14 1/16	8 7/16
3/8	11 1/4	6 3/4	16 7/8	10 1/8
7/16	13 1/4	8	19 11/16	11 13/16
1/2	15	9	22 1/2	13 1/2
5/8	18 3/4	11 1/4	28 1/2	16 7/8
3/4	22 1/2	13 1/2	34	20

[1] Groove tolerances are 1/32 inch maximum and 1/64 inch minimum for ropes up to 3/8 inch in diameter; 1/16 inch maximum and 1/32 inch minimum for ropes from 3/8 inch to 1 inch in diameter.

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